United States Department of Agriculture

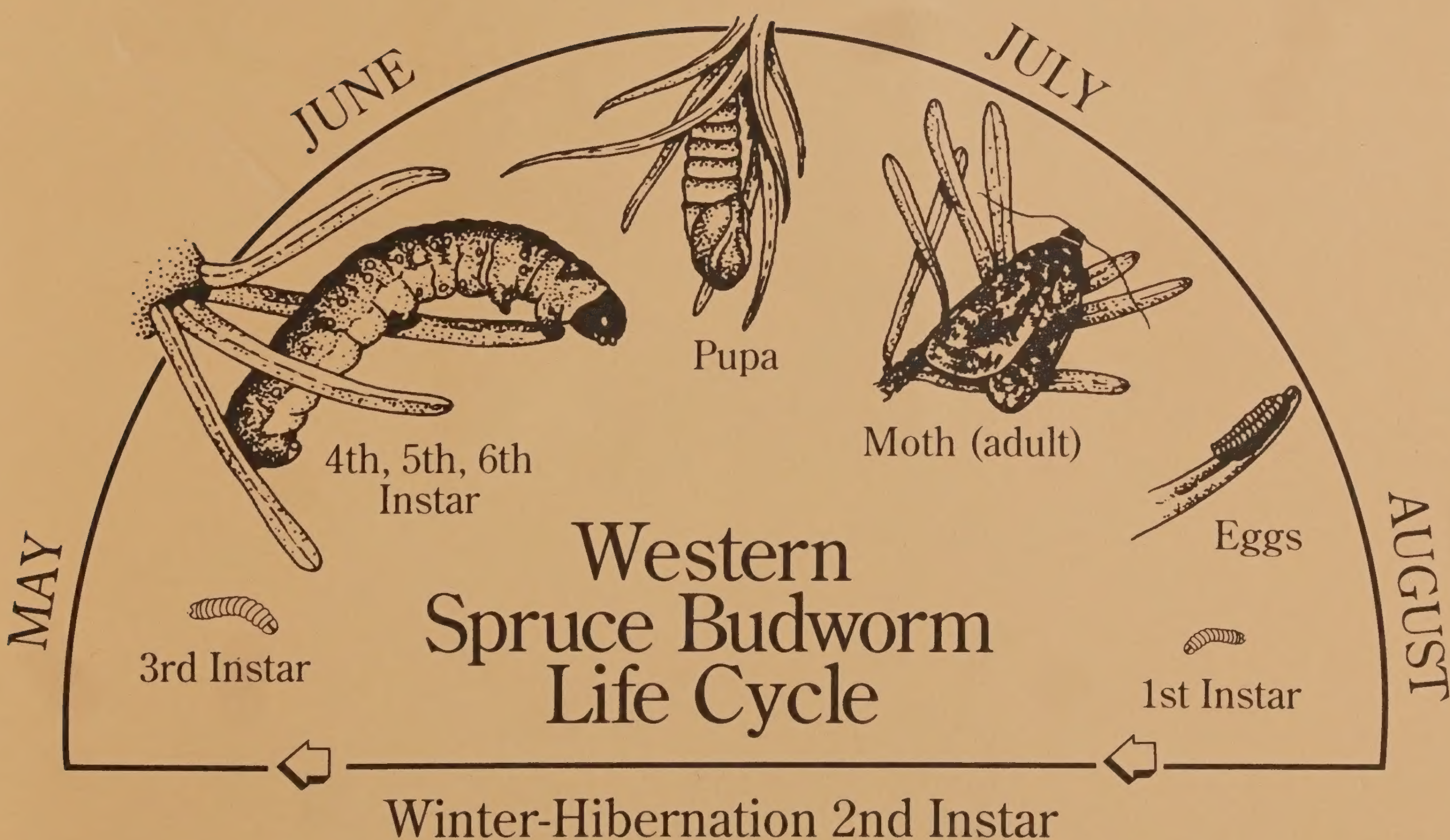
Forest Service

Forest Pest Management

Pacific Northwest Region

Draft Environmental Impact Statement SUMMARY

Management of Western Spruce Budworm in Oregon and Washington



Summary of

Draft Environmental Impact Statement for

Managing Western Spruce Budworm In Oregon And Washington

USDA Forest Service
Pacific Northwest Region
States of Oregon and Washington and Portions of California and Idaho

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Comments must be received by **December 22, 1988**

SUMMARY

Introduction

The Pacific Northwest Region (Region 6) of the USDA Forest Service is headquartered in Portland, Oregon. It includes Oregon, Washington, and parts of a few Counties in California and Idaho. In Region 6, the Forest Service administers 19 National Forests (including 1 National Grassland) totaling 24.5 million acres.

Terrain and vegetation vary widely across the Region. There is a great variety of landforms, from coastal dunes and flat grasslands to rolling hills, steep ridges, mountains, and volcanoes. Natural vegetation ranges from the Olympic rain forest to interior high deserts.

Managing the current outbreak of the western spruce budworm, affecting 19 National Forests in the Pacific Northwest, is a major effort.

This summary of the Environmental Impact Statement (EIS) discusses the issues and concerns raised by the public and other agencies, and Forest Service personnel regarding management of the current western spruce budworm infestation. The summary also describes the purpose and need for the proposed action, and explains how the major issues and concerns identified have been formulated into planning questions. It describes how four differing alternatives respond to these planning questions, and gives the environmental consequences implementing each.

After carefully considering comments from the public, scientists, and Government agencies , a Final Environmental Impact Statement (FEIS) will be prepared and issued. That final version will be the basis for selection of a program for managing future western spruce budworm infestations In National Forests in the Pacific Northwest.

Managing Forest Insects

Insects are part of forest ecological systems. They may play useful, as well as harmful, roles in those systems. Thus, an understanding of each ecological system is essential for effective management of forest insects, and is also necessary for long-term beneficial use of these insects.

Current Situation

Plant communities, Douglas-fir, Western larch, grand fir, white fir, Englemann spruce, and subalpine fir, on the east side of the Cascade Range have been experiencing an ongoing infestation of western spruce budworm. Although western spruce budworm is always present in the forest, epidemic levels of activity have been reached and the associated damage has caused considerable concern to landowners, recreationists, and other National Forest users. The current western spruce budworm outbreak now encompasses millions of acres and is expected to continue in size and intensity. Efforts to control the current infestation could have important consequences on the social, biological, and physical environment. This Environmental Impact Statement (EIS) examines those environmental impacts.

Decision Needed

The decision needed in this EIS is how to manage the current spruce budworm outbreak. During investigation of possible actions and their predictable environmental effects, four alternative programs were developed for managing the current outbreak of the western spruce budworm on lands administered by USDA Forest Service, Bureau of Land Management, Bureau of Indian Affairs, and State and private lands in Oregon and Washington. The EIS displays the environmental impacts and management implications of these four alternatives.

This EIS is presented in draft form to provide an opportunity for public review and comment. After carefully considering comments on this draft from scientists, Government agencies, and the public, a Final Environmental Impact Statement (FEIS) will be prepared and issued. The Regional Forester will use the FEIS as a basis for indicating the Regional Forester's Preferred Alternative.

Description Of The Insect

The western spruce budworm (*Choristoneura occidentalis* Freeman) is a native insect species. It is the most widely distributed and potentially destructive insect of coniferous forests in western North America. The western spruce budworm is one of nearly a dozen species, subspecies, or forms of a spruce budworm complex found throughout the western, north-central, and northeastern United States, and in several western and maritime Canadian provinces. The genus is also represented in Europe.

In Oregon and Washington, the budworm completes one cycle of development from egg to adult within 12 months. Following flight in late July and August, the adult moths lay eggs that soon develop into tiny larvae which overwinter in an inactive state in sheltered places, under bark scales, and in or among lichens on tree boles or limbs. In early May to late June, larvae emerge and begin their active feeding stage. As rapidly growing larvae, spruce budworms molt (shed their skin) a total of five times. The six intervening stages are called instars. After about 30 to 40 days, larvae develop into pupae. The moths emerge from the pupae after about 10 days to begin the cycle again.

The most common host tree species are Douglas-fir, grand fir, and white fir. Host species include subalpine fir, Engelmann spruce, western larch, lodgepole pine, and ponderosa pine. On most host tree species, western spruce budworm larvae feed as typical defoliators. Though preferring succulent new foliage, they also feed on older foliage when new foliage is in short supply or is not available. By the time larvae reach maturity in early to mid-July, they often have consumed or destroyed much of the new foliage on host trees.

Western spruce budworm larvae also feed on the cones and seeds of several species of host trees, particularly Douglas-fir (Dewey, 1970) and western larch (Fellin and Shearar, 1968).

Budworm populations are usually regulated by several natural factors such as parasites, predators, and adverse weather, especially when populations are low (Dewey, 1974). Starvation can also be an important mortality factor in regulating populations during prolonged outbreaks. More than 40 species of parasites are known which attack the budworm larval stage, but none has been found to have much effect on high budworm populations during an outbreak (Torgersen et al., 1984).

Public Involvement

There has been public involvement throughout development of this EIS. To help identify issues, concerns, and opportunities, a mailing requesting comments and concerns was distributed to approximately 2,000 addresses. One press release was mailed to the media in the affected areas.

A total of 209 responses were received through distribution of the scoping brochure and included approximately 550 comments. These comments were analyzed to determine whether they brought up new issues, proposed new alternatives not already considered, or proposed different analysis criteria to evaluate the possible alternatives.

Major Issues And Concerns

Beginning in 1981, and continuing through successive years of environmental analyses (EAs), numerous concerns have been expressed about the current western spruce budworm outbreak, and associated spray programs, in the Pacific Northwest. As the number of infested acres increased, the number of concerns grew, reflecting the opinions of individuals, organizations, and land managers. The issues and concerns developed during the 1984 northeastern Oregon analysis were used as a starting point to build upon during 1985. The public involvement steps used for scoping in 1986 included meetings and written inquiries. In 1986, 1987, and 1988, some additional public meetings were held by individual Forests. In addition, interested parties were solicited in writing for additional issues and concerns that were not addressed in prior EAs. Public meetings, personal consultations, news clippings, and correspondence resulted in identification of public issues and management concerns. These items reflected the views of concerned individuals, forest-based industries, landowners of various-sized forest holdings, forest resources user groups, conservation and environmental groups, Indian tribes, and representatives of local, State, and Federal agencies and governments.

Based on responses to mailings conducted as part of this EIS, and concerns identified in past EAs, eight major public issues were identified. Issues play a substantial role in forming the alternatives, in raising questions for analysis, and in the discussion and rationale for selection of the Preferred Alternative(s).

The eight public issues identified in this document include silviculture; water quality and quantity; fish, wildlife, and domestic animals; economics; human

health; effectiveness of treatment methods; timeliness of treatments; and fuels and fire. A discussion of these issues follows:

Silviculture

The effects on timber production of both treated and untreated budworm outbreaks are quite complex. Long-term management of timber stands through silviculture treatments as a means to end the epidemic is an issue. Therefore, budworm suppression programs would only minimize short-term growth losses. Concern has been expressed that untreated budworm infestations may negate efforts to increase timber growth rates through intensive timber management, and that long-term yields and harvests may be reduced from present levels. Some believe that timber from budworm-caused tree mortality needs to be harvested. Others are concerned the costs of salvaging and reforesting damaged stands far outweigh the costs of direct budworm control. It has been suggested that direct budworm control measures will be needed until timber stands contain healthy mixed species, less vulnerable to budworm infestation.

Water Quality and Quantity

Two broad areas of concern are included in this issue; possible hydrologic changes that might occur in watersheds if the budworm outbreak is left unchecked, and possible contamination of water quality from the use of insecticides. Some members of the public have asserted that widespread defoliation may result in variations to timing and quantity of water yield in heavily affected watersheds; increased flows could result in streambank cutting and greater sediment loads. Hydrologic changes could also affect unstable slopes and cause increased mass failure activity.

Fish, Wildlife, and Domestic Animals

People are concerned that fish, wildlife and domestic animals could be adversely affected to some degree by the budworm infestation or by insecticide control programs.

Big game species may be affected if budworm defoliation changes the quantity and/or quality of coniferous cover used for thermal, hiding, and escape cover. Some people expressed concern that ungulates (deer, elk) may be adversely affected by ingesting insecticides on forage. Since spraying of insecticides usually occurs about the same time as spring birthing, some people expressed concern about the effects of increased human disturbance on this critical biological activity (increased desertion of young, vulnerability to predation).

Economics

The benefits and costs of alternatives being considered for dealing with the budworm outbreak need to be displayed and compared. Many opinions have been expressed regarding factors that should enter into the economic efficiency analysis and the appropriateness of assumptions used in past analyses. Benefits and costs associated with the following factors have been suggested for consideration: timber growth loss, effectiveness of *B.t.* compared to carbaryl, risk of budworm population resurgence and reinvasion of treated areas, risk of future outbreaks in the area, and reduced recreation use.

Concern has been expressed regarding possible reductions in National Forest timber harvest levels because of the budworm outbreak and subsequent effects on employment and community stability.

Human Health

Most people who have expressed concern with budworm control projects want an understanding of hazards associated with the use of the insecticides being considered. The potential for long-term, short-term, and cumulative effects on human health is a concern. Possible effects on pregnant women, children, older people, and chemically sensitive people have been mentioned. Some are disturbed with the amount and type of data available to support decisions regarding the use of insecticides; others disagree with the choice of data and studies used or the conclusions reached by past risk analyses; and some categorically distrust risk assessments conducted by insecticide manufacturers, their contractors, or the Government.

Many of the people showing an interest in budworm control programs expressed a preference for continued use of biological rather than chemical insecticides. There are concerns about cumulative health risks from existing chemical use in the environment, and that additional chemical pesticide applications will add to human health hazards.

Effectiveness of Treatment Methods

The effectiveness of biological insecticides is dependent upon application techniques and proper timing. The efficacy of a biological insecticide is more dependent upon weather conditions than chemical insecticides. Unlike chemical insecticides, biological insecticides must be ingested by western spruce budworm larvae to be effective. The optimum conditions for treatment, therefore, result in a fairly narrow effective spray interval. Treating too early can result in many individual larvae escaping exposure to Bacillus Thuringiensis (*B.t.*) because they are not

feeding on foliage that is exposed to the spray, the effectiveness of *B.t.* can be diminished by exposure to sunlight before being ingested by larvae. Treatment administered too late might result in avoidance of *B.t.* by larvae that have advanced into the late sixth instar and have ceased feeding prior to pupation. Even with the best timing of spray applications, some larvae will survive due to the range of instars present, and the difference in host phenologies (as influenced by site, elevation, and other factors) over the spray block at the time of application.

Timeliness of Treatments

Throughout its range, detectable populations of western spruce budworm appear to persist indefinitely in stands that contain a substantial proportion of suitable hosts. Some feel that immediate suppression action could limit the spread of an infestation and prevent a widespread outbreak.

Wildfire

Many years of effective fire suppression efforts have caused accumulations of needle litter, dead limbs, and dead trees which can lead to high intensity wildfires. Outbreaks of mountain pine beetle, western spruce budworm, and Douglas-fir tussock moth have contributed and are presently increasing fuel loading. However, recent insect epidemics have increased the rate of accumulation.

Planning Questions:

1) What are the economic implications of potential alternatives?

The potential losses in timber growth and yield due to foliage loss are of concern. Visuals are also affected by spruce budworm as foliage becomes red or trees die. This may have an effect on the local economies of small communities dependent, in part, upon recreation income. Spraying and thinning projects bring dollars to the local economy by creating employment opportunities for local citizens, and purchasing goods and services.

2) How effective are available treatment methods in reducing the insect population? (Efficacy)

The efficacy of *B.t.* and other pesticides is directly related to the method of application, weather, and timing. Because *B.t.* is specific to lepidopteran species, there is little likelihood of adverse impacts from the use of *B.t.* on aquatic insects or fish.

3) What are the effects of each alternative on fish, wildlife, and domestic animals?

Concerns that increased human disturbance associated with control projects upon deer and elk during fawning and calving have been raised. Some people feel that fawns and calves would be more vulnerable to predation because of increased chances of desertion by the mothers. Bald eagle nesting territories occur within infested forests. There are concerns about the health effects on wildlife resulting from use of *B.t.* or carbaryl.

4) What is the effect of budworm treatment/nontreatment, on scenic values and recreation use?

Timber stands affected by the current spruce budworm outbreak will suffer various types and degrees of damage to wood fiber production. Treatment would avert most of the future predicted loss of wood fiber production due to the current outbreak.

5) What is the effect of, budworm treatment/nontreatment, on fuel loads and fire management?

As needles drop to the forest floor, the tops of trees die, and fuel loads increase. Due to the current outbreak, what is the likelihood and potential impact of an uncontrolled fire event under the various management options? What is the potential for fire ignition caused by human activities and lightning?

6) What are the hydrologic effects of treatment/nontreatment?

Concerns have been raised regarding the effects of the western spruce budworm infestation upon water quality and quantity. Some feel defoliation and tree mortality influence snowpack levels, seasonal snowmelt, stream temperatures, turbidity, and overland flows.

7) What is the timeliness of treatment for this and future outbreak cycles?

Concerns have been raised about the time lapse between the discovery of the outbreak and the start of treatment. Why isn't treatment effected at the beginning of the outbreak? Some do not understand why the treatment is effective only if applied during a short timeframe in late spring.

8) What are the effects on human health associated with treatment using *B.t.* and other chemicals?

USDA Forest Service Management Objectives

Management direction provided through laws, regulations, and policy, is detailed in a number of

places. The following references contain material applicable to alternatives being considered in this analysis: (These references are available at the USDA Forest Service, Pacific Northwest Regional Office in Portland Oregon).

A. Wilderness, Primitive Areas, and Wilderness Study Areas. Where a choice must be made between Wilderness values and any other activity, preserving the Wilderness resource is the overriding value. Economy, convenience, commercial value, and comfort are not standards of management, or use of Wilderness. Because uses and values on each area vary, management and administrative must be tailored to each area. Even so, all Wildernesses are part of one National Wilderness Preservation System and their management must be consistent with the Wilderness Act and their establishing legislation. This policy states that insect or disease outbreaks will not be artificially controlled unless it is necessary to protect resources outside the Wilderness. Insect or disease suppression projects in National Forest Wildernesses shall be based on factors set forth in FSM 2300 and 3400 and be approved by the Chief of the Forest Service.

B. Oregon and Washington State Forest Practices Act. The Oregon Forest Practices Act provides for a set of rules establishing minimum standards which encourage and enhance the growing and harvesting of trees. At the same time, the Act considers and protects other environmental resources - air, water, soil, and wildlife.

C. Federal Insecticide, Fungicide, and Rodenticide Act of 1972 as amended (Public Law 92-516). Is the authority for the registration, distribution, sale, shipment, receipt, and use of pesticides. The Forest Service may use only pesticides registered or otherwise permitted in accordance with the Federal Insecticide, Fungicide, and Rodenticide Act, as amended.

D. Environmental Protection Agency Regulations. These regulations include air and water quality standards that must be met. The U.S. Environmental Protection Agency (EPA) has responsibility, under a variety of statutes, to protect the quality of the Nation's ground water and air quality, as well as direct responsibility for regulating the availability and use of pesticide products.

E. Endangered Species Act. Plant or animal species identified by the Secretary of Interior as endangered in accordance with the 1973 Endangered Species Act, as amended. The goal of the sensitive species program is to maintain viable populations of sensitive species to ensure they do not become threatened or endangered because of Forest Service actions. Population and/or habitat objectives need to be developed and implemented for most of the species listed by the Regional Forester.

F. Any implemented project will comply with other applicable local, State, and Federal laws, regulations, or policies.

G. Treatments will comply with the direction provided in the most recently approved Land Management Plan for National Forest System lands.

USDA Forest Service Goals

Insect outbreaks will be prevented or suppressed by methods that will restore, maintain, or enhance the quality of the environment. These objectives are attained on non-Federal lands through cooperation with State Foresters or equivalent State officials. Insects are suppressed directly on National Forest System lands and in cooperation with responsible officials on other Federal lands. The Forest Service has cost-share agreements with the States of Washington and Oregon. These agreements allow the Forest Service to pay for a portion of the suppression of spruce budworm on private lands.

A principal U.S. Department of Agriculture goal is to assure an adequate supply of high quality food and wood fiber and a quality environment for the American people. The USDA gives special emphasis to the development and use of efficient and environmentally acceptable integrated pest management systems.

Alternatives

Introduction

This Environmental Impact Statement (EIS) displays four different ways of managing the western spruce budworm, including a No-action Alternative. Each of the three action alternatives utilizes a different treatment with a biological or chemical insecticide, or a combination of both types of insecticides.

Development Of Alternatives

Alternatives Considered But Eliminated From Detailed Study

The Forest Service considered a range of alternatives in order to assess the reasonableness of the

alternatives to be considered in detail. Those alternatives eliminated from detailed study, along with the rationale for their elimination, are as follows:

1. Suppression using biological methods other than *B.t.*

2. Indirect Suppression Using Silvicultural Techniques

3. Suppression Using the Chemical Insecticides Mexacarbate, Acephate, and Malathion.

Alternatives Considered In Detail

Four alternatives were considered in detail for this EIS.

Alternatives B and D are the Forest Service preferred alternatives.

Objectives Used In Designing Alternatives

The issue-driven objectives used in designing all action alternatives include:

1. meeting or exceeding water quality standards;

2. maintaining wildlife habitats and populations;

3. minimizing any potential risks to human health and the human environment;

4. utilizing an effective and economically sound method of management.

Alternative A: (No Action)

This alternative provides no direct suppression action to reduce the western spruce budworm population to nondamaging levels. The budworm infestation would be allowed to continue until it collapses due to natural factors.

Current management practices in the infested areas would continue. Scheduling and timing of these activities could be affected by the budworm outbreak. Silvicultural prescriptions may be changed to respond to forest stand damage.

Western spruce budworm activity would be monitored annually with an aerial sketchmap survey to determine the extent of visible defoliation.

Alternative B (Preferred)

This alternative would provide direct suppression utilizing the biological insecticide *B.t.*

This short-term alternative consists of suppression projects to protect resource values (commodity and noncommodity) that are truly at risk of unacceptable damage. It would involve the aerial application of the biological insecticide *B.t.* to selected areas with the objective of reducing budworm populations to nondamaging levels.

Alternative C

This alternative would utilize direct suppression with the use of chemical insecticides.

This short-term alternative consists of suppression projects to protect resource values (commodity and noncommodity) that are at risk of unacceptable damage. Four chemical insecticides, malathion, acephate, mexacarbate, and carbaryl, are currently registered by the Environmental Protection Agency for suppression of western spruce budworm by aerial application. This alternative discusses only the use of carbaryl. At this time, carbaryl is the most acceptable chemical insecticide in terms of efficacy in suppressing budworm populations. Application of carbaryl would involve aerial broadcast treatment of infested areas, while leaving at least a one-swath untreated (buffer) strip on either side of streams and around bodies of water. The objective would be to reduce budworm populations to nondamaging levels for at least a major portion of the current outbreak.

Alternative D: (Preferred)

This alternative would combine the use of *B.t.* and the chemical insecticide carbaryl.

This short-term alternative consists of suppression projects to protect resource values (commodity and noncommodity) that are at risk of unacceptable damage. This would include the use of *B.t.* up to, but not over streams or other bodies of water. Carbaryl would be used up to a buffer strip along streams or around other bodies of water. *B.t.* could be used in the buffer strips. The choice of carbaryl or *B.t.* over the majority of the treatment area would be determined on a project-specific basis. The particular attributes of each area, including amounts of sensitive areas and humans habiting or frequenting the unit, would be considered in the decision.

A comparison of these alternatives follows:

Comparison Of Alternatives

Planning Question #1:

What are the economic implications of the alternatives?

Alt. A. (No Action)	Long-term reduction in future supply of wood fiber; short-term increase of logs for manufacturing due to salvage operations.
Alt. B. (Use of *B.t.* only)	Long-term supply of wood fiber maintained; short-term increases in expenditures to local economies for services rendered.
Alt. C. (Use of Carbaryl only)	Long-term supply of wood fiber maintained; short-term increases in expenditures to local economies for services rendered.
Alt. D. (Use of both *B.t.* and Carbaryl)	Long-term supply of wood fiber maintained; short-term increases in expenditures to local economies for services rendered.

Planning Question #2:

How effective are the treatment methods?

Alt. A. (No Action)	No effect on achieving lasting budworm population reductions.
Alt. B. (Use of *B.t.* only)	Applications are likely to suppress budworm populations below identified threshold levels; populations unlikely to develop a tolerance; resurgence and reinvasion are not anticipated.
Alt. C. (Use of Carbaryl only)	Applications are likely to suppress budworm populations below identified threshholds; budworm populations can develop a tolerance to carbaryl applications; reinvasion may occur from streamside buffer strips; resurgence is a potential problem.
Alt. D. (Use of both *B.t.* and Carbaryl)	Flexibility to utilize both *B.t.* and/or carbaryl as the situation warrants, is likely to suppress budworm populations below identified threshhold levels; reinvasion need not occur; resurgence may occur.

Planning Question #3:

What are the effects of alternatives on other resources?

Alt. A. (No Action)	Implementation of this alternative would not produce adverse impacts to other resources.
Alt. B. (Use of *B.t.* only)	Implementation of this alternative would not produce significant impacts to other resources. Some resources such as general wildlife populations, may benefit slightly.
Alt. C. (Use of Carbaryl only)	Implementation of this alternative may produce significant impacts to some resources. Specifically, some species of small mammals, birds, and insects may

be adversely affected by the toxological properties of carbaryl.

Alt. D. (Use of both *B.t.* and Carbaryl)	Implementation of this alternative, correspondent with established mitigation measures, may result in minor impacts to some resources. Significant impacts would probably be mitigated by the use of B.t. in sensitive ecosystems.

Planning Question #4:

What is the effect of each alternative on visual quality?

Alt. A. (No Action)	Severe defoliation will result in color and texture changes for up to a decade or more; changes to visual quality could result in decreased recreational use, with a coresponding impact on the recreation economy.
Alt. B. (Use of *B.t.* only)	Treatment would provide short-term protection of foliage; changes to color and texture of the landscape are reduced but not eliminated; cumulative mortality and top-kill would be reduced; only slight reductions in recreation user days would be expected; a forest with tree species susceptible to continued defoliation would be maintained.
Alt. C. (Use of Carbaryl only)	Treatment would provide short-term protection of foliage; changes to color and texture of the landscape are reduced but not eliminated; cumulative mortality and top-kill would be reduced; only slight reductions in recreation user days would be expected; a forest with tree species susceptible to continued defoliation would be maintained.
Alt. D. (Use of both *B.t.* and Carbaryl)	Treatment would provide short-term protection of foliage; changes to color and texture of the landscape are reduced but not eliminated; cumulative mortality and top-kill would be reduced; only slight reductions in recreation user days would be expected; a forest with tree species susceptible to continued defoliation would be maintained.

Planning Question #5:

What is the effect of alternatives on fuels and fire?

Alt. A. (No Action)	Minimal impact on fuel loading in areas where only scattered mortality has occurred; severe defoliation and continuous mortality will result in significant increases to fuel loading; fire intensity is expected to be high; fire line construction will be slow.
Alt. B. (Use of *B.t.* only)	Short-term potential for heavy fuel buildup would be reduced or eliminated; scattered mortality would occur; existing fuel loadings would not be significantly increased; projected fire intensity and fireline construction rates would not be slowed.
Alt. C. (Use of Carbaryl only)	Short-term potential for heavy fuel buildup would be reduced or eliminated; scattered mortality would occur; existing fuel loadings would not be significantly increased; projected fire intensity and fireline construction rates would not be slowed.
Alt. D. (Use of both *B.t.* and Carbaryl)	Short-term potential for heavy fuel buildup would be reduced or eliminated; scattered mortality would occur; existing fuel loadings would not be significantly increased; projected fire intensity and fireline construction rates would not be slowed.

Planning Question #6:

What are the hydrological effects of treatment and nontreatment?

Alt. A. (No Action)	No significant increase in annual streamflow or peak discharge is anticipated as a direct result of defoliation and mortality. Cumulative impacts from defoliation and extensive management activities could produce significant increases in annual streamflow. These increases could degrade water quality. Defoliation and mortality could promote slight increases in water temperature in some stream segments.
Alt. B. (Use of *B.t.* only)	This alternative would reduce defoliation while minimizing impacts described in the No-action Alternative.
Alt. C. (Use of Carbaryl only)	This alternative would reduce defoliation while minimizing impacts described in the No-action Alternative.
Alt. D. (Use of both *B.t.* and Carbaryl)	This alternative would reduce defoliation while minimizing impacts described in the No-aAction Alternative.

Planning Question #7:

What is the timeliness of treatment for this and future outbreak cycles?

Alt. A. (No Action)	Implementation of this alternative would allow the budworm infestation to follow its natural course. It would have no effect on the frequency of future outbreak cycles.
Alt. B. (Use of *B.t.* only)	Implementation of treatments prescribed in this alternative is timely. Sufficient time has elapsed to indicate that the outbreak is persisting despite natural enemies. Earlier treatment would not have prevented the "spread" of budworm infestation. The application of *B.t.* should have no effect on future outbreaks.
Alt. C. (Use of Carbaryl only)	Implementation of treatments prescribed in this alternative is timely. Sufficient time has elapsed to indicate that the outbreak is persisting despite natural enemies. The application of carbaryl (with buffers where appropriate) may have an effect on the ability of budworm populations to reinvade and resurge, thus affecting future outbreaks.
Alt. D. (Use of both *B.t.* and Carbaryl)	Implementation of treatments prescribed in this alternative is timely. Sufficient time has elapsed to indicate that the outbreak is persisting despite natural enemies. The application of sublethal dosages of carbaryl may stimulate budworm populations and contribute to the resurgence of vigorous populations.

Planning Question #8:

What are the effects on human health associated with treatments using *B.t.* and other chemicals?

Alt. A. (No Action)	This alternative would have no effect on human health since the alternative does not employ chemical insecticides or biological controls.

Alt. B. (Use of *B.t.* only)	This alternative presents the least risk of the direct suppression alternatives. The use of *B.t.* poses little risk of acute or chronic effects upon human health.
Alt. C. (Use of Carbaryl only)	This alternative presents the highest risk to human health of the direct suppression alternatives. Carbaryl poses a human health risk only in the case of accidents. The petroleum distillate carrying agents (kerosene and diesel oil) commonly used for application present a risk under routine worst-case conditions, and in the case of accidents.
Alt. D. (Use of both *B.t.* and Carbaryl)	This alternative presents human health risks of an intermediate nature. Risks would be reduced to the extent that *B.t.* is used instead of carbaryl.

Affected Environment

Location

The Pacific Northwest Region (Region 6) includes the States of Oregon and Washington, as well as small portions of northern California and western Idaho. The region covers a total area of 106 million acres. The USDA Forest Service administers 24.5 million acres of this area, divided into 19 National Forests and 1 National Grassland. The Forest Service also assists in the protection and management of 20.5 million acres of other commercial forest lands through cooperative programs with private landowners, and State and local governments.

Water Quality and Quantity

The National Forests occupy 23 percent of the land in the Pacific Northwest, yet 44 percent of the region's water supply originates on National Forest land.

About 6 million acres, approximately one quarter of National Forest lands, are managed specifically as domestic watersheds. About 800,000 acres are managed according to formal agreements with fifteen municipalities. The quality and quantity of water produced by National Forests is dependent upon the management of vegetation and soils in each watershed.

Plant Communities

All true fir and Douglas-fir stands are potential hosts for western spruce budworm. The current epidemic is located primarily on the east side of the Cascade Range.

Over the last century, the vegetative composition of National Forests has changed greatly. These changes are especially evident on the East-side Forests. Heavy grazing by horses, sheep, and cattle at the turn of the century tended to increase the early stages of forbs and grasses. Aggressive fire prevention and suppression practices over the past 80 years helped to convert open grasslands to tree-growing sites, and open pine stands to thickets of mixed conifer species. In other areas, the late seral stages of tree species were greatly increased later in the 1950's and 1960's by logging practices which selectively removed the ponderosa pine.

The change in species composition from ponderosa pine to white fir or Douglas-fir is accompanied by increased susceptibility to insects and disease. Insects and disease are not new to the forests, but as their host types increase, the potential for their occurrence also increases.

The increase in host type is not the only factor in the current western spruce budworm outbreak. Most of the understory stands of white fir and Douglas-fir have been suppressed by the ponderosa pine overstory. Removal of the pine overstory has not released the firs to grow freely. The shade-tolerant understory is overstocked and unthrifty. The poor health of these stands, compounded by the present drought cycle, has resulted in thousands of acres of susceptible host trees.

Insect-caused tree mortality on the forests has been heavy during the past 20 years. Primary causal agents have been Douglas-fir tussock moth, mountain pine beetle, and western spruce budworm. Currently, western spruce budworm and mountain pine beetle are causing the largest amount of mortality.

Timber

Much of the land within the National Forests of the Pacific Northwest Region is among the most productive forest land in the world. Roughly 90 percent of National Forest lands are forested.

Demand for timber will vary with market and economic conditions, and is affected by short-term decisions of other industrial and agency forest ownerships. As a general situation, however, there are purchasers for all volumes made available for harvest. Recent trends of both harvest levels and acres available for regulated harvest (the systematic removal of products) are reflected in Forest land management planning processes. While conditions vary from Forest to Forest, the trend is for somewhat reduced programmed harvest levels in comparison with recent historic levels.

Wildlife and Wildlife Habitat

Forests of the Pacific Northwest Region are known to provide habitat for 569 species of resident and migratory, terrestrial vertebrate wildlife (174 mammals, 335 birds, and 60 reptiles and amphibians).

In order to maintain viable, self-sustaining populations of wildlife, an appropriate amount and distribution of suitable habitat must exist. The amount and distribution of habitat will vary over time. Changes in habitat condition and suitability can occur abruptly (as the result of fire, windstorm, or timber harvest), or more gradually (as in the slow replacement of plant communities characteristic of succession).

In the absence of human manipulation, natural landscapes support characteristic patterns of plant communities and stand conditions. These reflect, in

part, the frequency of disturbances, site productivity, and successional changes that occur over time.

Threatened, Endangered, and Sensitive Animal Species

Six wildlife species currently listed by the U.S. Fish and Wildlife Service as endangered or threatened under the Endangered Species Act are known or suspected to occur on National Forest lands in the Pacific Northwest.

These species differ widely in their distribution in the Northwest. The brown pelican is known only from coastal portions of the Siuslaw National Forest. Woodland caribou occur only on the Colville National Forest. In the State of Washington, grizzly bear and gray wolf have documented or suspected occurrences in four and five Forests, respectively. Peregrine falcons are known or suspected to occur on all but three National Forests in the Region, and the bald eagle is known to have nesting, winter roosting, or migratory sites on all 19 Forests.

Thirty-six other species (8 mammals, 14 birds, 1 reptile, 3 amphibians, and 10 fish) are included on the Regional list of Sensitive Species. All Forest Service activities that might disturb these species or their habitat must be preceded by a biological evaluation (Forest Service Manual 2670).

Threatened, Endangered, and Sensitive Plant Species

On National Forest lands in Oregon and Washington, only one plant species currently listed under the Endangered Species Act is known to occur. MacFarlane's four-o'clock (*Mirabilis macfarlanei*) is listed as endangered. It is known to occur at only a few locations in the Snake River country of Oregon and Idaho.

Fisheries

The Pacific Northwest Region has approximately 15,000 miles of streams that directly support both resident and anadromous fish. There are approximately 150,000 acres of lakes and 65,000 acres of reservoirs that can support both warm and cold water species of fish.

Resident game fish include rainbow, eastern brook, Dolly Varden, and cutthroat trout; crappie; bluegill; yellow perch; smallmouth and largemouth bass; Kokanee; and mountain whitefish. Anadromous fish (fish that spawn in fresh water and migrate to the ocean to mature) have both sport and commercial value. They are found on 15 of the 19 Forests in the Region.

Insect (management) activities have the potential to affect fish habitat characteristics such as water temperature; sediment load; turbidity; water quantity, timing of flows; and the character of streamside vegetation. The quality of fish habitat is dependent upon management practices within watersheds.

Visual Resources

Scenic diversity in the Pacific Northwest Region contributes greatly to the recreational value of the Forests. A few examples of this diversity include coastal forests, jagged peaks in the North Cascades, the high desert of central Oregon, moss-draped trees in the Olympic rain forest, and the Blue Mountain and Snake River areas.

The landscape management objective is to manage all National Forest System lands to attain the highest possible visual quality compatible with other appropriate public uses, costs, and benefits. In order to comply with the objective, the USDA Forest Service developed the Visual Management System.

Sightseeing is an important component of Forest recreational activities. Most of this activity occurs along major road, trail, and river corridors. Areas that can be seen from these travelways are called viewsheds.

Natural agents can also have a negative effect on visual quality. Wildfire, wind, insects, and disease are among natures causal agents. The eruption of Mount St. Helens had a vast impact on thousands of acres.

Recent examples of insect infestation effects on visual quality are the lodgepole stands suffering from the current mountain pine beetle attack on the Deschutes National Forest, and the tussock moth epidemic in the 1970's on the Wallowa-Whitman National Forest. At the present time, a widespread western spruce budworm infestation is resulting in millions of acres of dead foliage and trees in eastern Oregon and Washington.

Wildfire

Fire, and its exclusion, has been a significant factor in the development of plant communities on the National Forests, especially on the east side of the Cascades. All vegetational types have developed subsequent to fires of natural origin. The frequency and intensity of those fires has, to varying degrees, determined the species of trees present on different sites.

The National Forests have continued to operate under an aggressive fire suppression policy, taking

immediate control action on all unplanned ignitions. This policy of fire suppression has had unexpected side effects. One effect is a decades-long buildup of fuels in some areas. A second effect is that vegetation types have also been changing.

Social and Economic Conditions

The area of influence for the purposes of this report--the people and communities most directly influenced by National Forest management activities and outputs of the Pacific Northwest Region--comprises the States of Oregon and Washington. The major geological feature is the Cascade Mountain Range, which parallels the Pacific coastline about 100 miles inland. This rugged range divides the region into two distinct zones, west and east. Climate, vegetation, the economy, and population patterns are different on the west and east sides of the Cascades.

The western part of the region has 5.7 million people. It contains the majority of the population of the two States. Eighty-seven percent of Oregon's population, and 69 percent of Washington's reside west of the Cascades. The economy in the western portion of the region is relatively diversified; more so in Washington than in Oregon.

The eastern part of the region covers two-thirds of the land area of Oregon and Washington. It contains a smaller proportion of the population: about 13 percent of Oregonians and 31 percent of Washingtonians live east of the Cascade Mountains. The economy of the eastern portion of the region depends more on agriculture, forest products industries, and the livestock industry than does the western portion.

Land Uses

Landownership patterns within the Pacific Northwest Region of the Forest Service are highly complex around and within National Forest boundaries. Many of the private holdings are managed for timber production by private industrial owners. State and Federal agencies (the Oregon Department of Forestry, Washington Department of Natural Resources, and the USDI Bureau of Land Management, for example) also manage large tracts of land within and adjacent to the boundaries of the Region.

Public Health

The States of Oregon and Washington had a combined population of approximately 7 million people as of 1984. People in the region enjoy above-average good health, compared to the total U.S. population. The Forest Service reports a trend of increasing numbers of residents living near National Forests. This increasing proximity of people living near lands managed by the Forest Service has resulted in increasing public concern with environmental issues such as air and water quality, and public health.

Environmental Consequences

Estimating Environmental Consequences

Environmental consequences (or effects) occur when ecosystems are changed---whether through management action or inaction. This chapter presents the environmental consequences of the no action and action management alternatives.

In addition to this EIS, if an action alternative is selected, project-specific environmental analysis will be required before project implementation.

Water Quality/Quantity

Based upon the maximum anticipated basin defoliation rates projected for a spruce budworm infestation, and the similarity between tussock moth and spruce budworm infestations, no significant increase in streamflows or peak discharges should result solely from spruce budworm impacts. However, significant increases in annual streamflow could result from the cumulative impacts of a severe budworm defoliation and management activities.

Alternative A

Alternative A, the No-action Alternative, should have minimal impacts on water quality and quantity.

Alternatives B, C, and D

Implementation of Alternatives B, C, and D would reduce defoliation and eliminate the slight impacts described in the No-action Alternative. Also, that portion of a cumulative impact attributable to defoliation would be removed.

Mitigating Measures

Aerial insecticide application near streams and open water is controlled by State law.

A buffer zone will be left adjacent to streams, lakes, wetlands, and other waterways when applying

carbaryl. This buffer strip must be at least one swath wide.

Vegetation

Alternative A

The No-action Alternative, over time, would open pockets in the tree canopy due to mortality. The cumulative effect of this alternative would be a gradual change of stand structure over time.

Alternatives B, C, and D

The action alternatives would tend to keep stands and attendant plant communities in their present state of development.

Timber

Timber stands affected by the current spruce budworm outbreak suffer various types and degrees of damage to wood fiber production. The most measurable result is growth loss.

Potential for Growth Loss

Alternative A

A major impact of budworm defoliation on a timber stand is growth loss. Under the No-action Alternative, the maximum amount of budworm-caused growth loss would continue until the population collapsed due to natural regulating factors, or until a subsequent analysis determined that suppression measures were needed. In the long term, as the host trees are replaced by more resistant species, growth loss due to the infestation would become less.

Cumulative effects on timber would be a continuing and expanding loss of fiber production until the outbreak cycle collapsed or stand replacement occurred.

Alternatives B, C, and D

Projections show that implementation of these alternatives would result in a level of budworm population control that would avert most additional loss of wood fiber production due to the current outbreak. Cumulative effects on timber production would be a reduction in volume lost due to reduction of height growth and mortality.

Alternative A

Harvest volume impacts due to tree mortality will depend upon both the intensity and duration of the infestation. Scattered mortality may be beneficial in some instances. Mortality of budworm host trees may actually accelerate the growth of nonhost trees.

Under this alternative, forests would exhibit a maximum amount of mortality caused by an outbreak allowed to continue until collapse due to natural regulating factors.

Alternatives B, C, and D

With the action alternatives, there would be very little budworm-caused mortality in undamaged stands.

Potential for Top-kill and Deformity

Alternative A

In general, assessments of top-kill have shown its frequency to vary among and within stands. Under the No-action Alternative, the maximum amount of top-kill and deformity caused by a full-term budworm outbreak would be experienced.

Alternatives B, C, and D

Under these alternatives, top-kill and deformity due to budworm damage as described in Alternative 1, could be averted in stands which have not yet experienced top-kill.

Insect Complex

Because of uncertainties about western spruce budworm behavior and population dynamics, the ability to achieve a lasting reduction in budworm populations is a concern. The following discussion addresses six categories of uncertainties identified during scoping for this analysis; the outbreak cycle, reinvasion, resurgence, timing, tolerance, and efficacy:

Outbreak Cycle

Two conditions currently believed to cause outbreaks of the western spruce budworm are an abundant food supply (extensive stands of Douglas-fir and true firs) and favorable weather (Fellin et al., 1983).

Human intervention in the ecosystem through timber harvesting practices and control of wildfires has led to large acreages of true fir and Douglas-fir (West, 1969; Hall, 1980; Schmidt, 1981). This readily available food source, combined with favorable (warm and dry) weather during May, June, and July, can lead to an outbreak (Hard et al., 1980; Ives, 1981; Twardus,

1982). Natural enemies, such as parasites and predators, both vertebrate and invertebrate, apparently exert little control over budworm populations moving into an epidemic situation (Miller and Renault, 1976; Ives, 1981; Campbell and Torgersen, 1982; Torgersen et al., 1984).

Prolonging a budworm outbreak or increasing the frequency of outbreaks through the use of insecticides is potentially a problem but is insignificant in comparison to the proliferation of extensive areas of the preferred hosts (Blais, 1983; Fellin, 1983).

Reinvasion

It is reasonable to assume that in the absence of substantial geographic barriers or breaks in host-type, adult moths will move freely in their search for host plants.

Resurgence

The third uncertainty is whether budworm populations, reduced by treatment, remain at low levels or build back up (resurge) to outbreak numbers. The lower the budworm population densities are suppressed and the least impact on natural enemies, the higher the probability the population will not resurge.

Timing

Throughout its range, detectable populations of budworm appear to persist indefinitely in stands that contain a substantial proportion of suitable hosts. Treating early in an outbreak does not prevent "spread" of budworm.

Tolerance to Insecticides

The development of population tolerance to insecticides generally requires heavy selection pressure from the repeated use of a particular insecticide.

It is generally considered difficult for insects to develop resistance to microbial insecticides, such as *B.t.*, because of their complex modes of action.

Efficacy

Aerial application of insecticides is very complex because there are so many variables that are uncontrollable. Differences in elevation, slope,and aspect result in varying times of insect and foliage development over an area. Careful attention to each of these variables increases the probability of budworm larvae consuming a lethal dose of insecticide.

Alternative A

Use of the No-action Alternative has no effect on achieving lasting budworm population reductions. Use of this alternative does not preclude the long-range prevention of budworm outbreaks through current and future forest management practices.

Alternative B

Applying *B.t.* is not considered likely to prolong the outbreak. Application should have no effect on natural enemies. When populations of budworm are suppressed, the natural enemies should be able to again exert their controls.

Quality *B.t.* applications are likely to suppress budworm populations below the established threshold of less than an average of 1 larva per branch tip.

Alternative C

Applying carbaryl is not considered likely to prolong the outbreak, and should have only minor effects on natural enemies.

Reinvasion from untreated areas within the treatment areas is a potential problem.

Resurgence is a potential problem with carbaryl.

The use of carbaryl would not affect the timing of treatment of damaging populations.

Studies show budworm populations can develop a tolerance to carbaryl applications.

Quality carbaryl applications are likely to suppress budworm populations below the established threshold of less than an average of 1 larva per branch tip.

Alternative D

Selection of either *B.t* or carbaryl would allow managers to use the one in a particular situation which best meets the needs of a particular situation. When there is no practical difference, or no concern about potential effects, the choice may be made on economic or other reasons.

Wildlife

Alternative A

Taking no action, and allowing continued spruce budworm infestation, will result in minor reductions of hiding and thermal cover for big game. Offsetting these losses will be an increase of forage production associated with reduced tree crown cover. Both effects are expected to be of little consequence.

Beneficial effects include slight increases in nesting habitat for cavity nesters and perches for raptors as a result of tree mortality and top-kill. Overall, it appears general wildlife populations benefit slightly from the current spruce budworm infestation. Benefits are transitory and are not expected to last much longer than the infestation.

Alternative B

Impacts upon wildlife result primarily from increased human activity associated with treatment projects. Coverage of large areas by personnel and equipment increases the disturbance factor.

Field tests have not revealed any deleterious effects of *B.t.* on populations of birds and mammals.

Except for lepidopterans, no toxicity to zooplankton, arthropods, fish, birds, mammals, and other wildlife or domestic species, has been demonstrated at levels recommended for field application.

Since *B.t.* is not a broad-spectrum insecticide and affects only lepidopterans (moths and butterflies), expected impacts upon terrestrial organisms are slight. Most beneficial insects would not be affected.

Alternative C

The risk to wildlife species from spruce budworm suppression with carbaryl is a function of the inherent toxicity (hazard) of the insecticide to different organisms, and the amount of chemical (exposure) those organisms may take in as a result of a spraying operation.

For wildlife risks, the criteria used by the Environmental Protection Agency (EPA, 1986) in ecological risk assessments were used to judge absolute risks to the different representative species. Because carbaryl showed no tendency to bioaccumulate, long-term persistence in food chains and subsequent toxic effects, such as those resulting from use of persistent organochlorides, are not considered a problem.

Wildlife Risk Overview

In general, based on available toxicity data and proposed application rates, risks to wildlife are low to negligible in the spruce budworm suppression program.

Carbaryl

No realistic or extreme doses of carbaryl exceed the EPA risk criterion. Alternative C would not present a risk to wildlife.

Diesel Oil and Kerosene

Wildlife exposures are far below the EPA risk levels for these two chemicals and, under this program, there would be no risk to wildlife from their use.

Invertebrates

Aquatic insects in the orders Plecoptera (stoneflies) and Ephemeroptera (mayflies) are highly sensitive to low levels of carbaryl. Trichoptera (caddisflies) and Diptera (true flies) are also sensitive to carbaryl.

Carbaryl

Mammalian Toxicity

Carbaryl is considered moderately toxic to mammals and slightly toxic to birds.

Avian Toxicity

Results of carbaryl studies on birds vary. A number of studies have reported no effect on bird populations in areas treated with carbaryl. One study reported significant declines in bird populations, possibly resulting from reduced food supplies.

Effects on Avian Reproduction

Studies indicate the possibility that extensive use of carbaryl may cause a significant reduction in reproductive success of avian species, especially quail and pheasant.

Toxicity to Honey Bees

Carbaryl is very toxic to honey bees (Union Carbide, 1980).

Toxicity to Other Beneficial Insects

Because carbaryl acts as a broad-spectrum pesticide (EPA, 1980), a certain amount of toxicity to a wide variety of insects and other arthropods may be expected. Many insects in the order Hymenoptera (this order includes the honey bee) seem to be especially susceptible to carbaryl (Abu and Ellis, 1977; Adams and Cross, 1967; Plapp and Vinson, 1977; Stern, 1963).

Aquatic Toxicity

Concentrations of approximately 10 ppm carbaryl are lethal to three of five species of marine algae.

Toxicity of 1-Naphthol

The major microbial degradation product of carbaryl is 1-naphthol. In a laboratory study (Stewart et al., 1967), carbaryl was shown to be 30 to 300 times more toxic than 1-naphthol to crustaceans (shrimp and crabs).

Diesel Oil

Mammalian Toxicity

According to the American Petroleum Institute (1983), the major hazards to mammals from diesel oil in the environment include the adherence of oil to the fur of animals, possibly resulting in hypothermia, and sublethal effects in small mammals from contaminated forage.

Toxicity to Beneficial Insects

Based on available studies, diesel oil appears to be highly toxic to honey bees, suggesting the potential for a high degree of toxicity to other invertebrates. The use of adjuvants, such as spray oil, diesel oil, and surfactants, with insecticides causes slightly increased mortality of honey bees.

Avian Toxicity

Diesel oil is slightly toxic to birds.

Threatened, Endangered, And Candidate Species

A set of mitigating measures, developed with concurrence from the U.S. Fish and Wildlife Service that will result in no effect to nesting eagles, will be incorporated in project operations plans and implemented during treatment.

A list of candidate species, which may occur in some areas, was also provided by the U.S. Fish and Wildlife Service. No effect from treatment is anticipated for these species.

In areas planned for treatment, the project leader will coordinate with the Forest Threatened, Endangered, and Sensitive Species Coordinator, and take appropriate action to assure that threatened, endangered, or sensitive plants are protected.

Fisheries/Aquatic Ecosystem

Alternative A

No effects on fisheries resulting from water temperature increases are expected.

The No-action Alternative, having minimal adverse impacts on water quality, would have similar minimal effects on fisheries. Aquatic invertebrates would not be affected by the No-action Alternative.

Alternative B

Few toxic effects have been reported in studies of aquatic species exposed to *B.t.*

Alternative D

The impact on fisheries and aquatic systems is expected to be the same as effects from Alternatives B or C.

A buffer zone will be left adjacent to streams, lakes, wetlands, and other waterways when applying carbaryl. This buffer strip must be at least one swath wide.

Aquatic Toxicity

Fish

Diesel and jet fuels and fuel oils are moderately to highly toxic to fish (based on the toxicity categories of EPA, 1985).

The risk of adverse effects from exposure to insecticides that drift offsite, and accidents, was estimated for the representative aquatic species.

The results of the risk analysis indicate there is no significant risk of acute adverse effects to any of the representative aquatic species for typical and worst-case exposures resulting from drift.

Carbaryl degrades rapidly in water in 1 to 5 days.

Fate in Plants

The low vapor pressure of carbaryl makes it unlikely that it will volatilize from plant surfaces. The susceptibility of carbaryl to photolysis, and its low solubility, minimize the possibility of washoff from plants.

Small amounts of carbaryl may be absorbed by roots and foliage and distributed into plants (EPA, 1984).

Carbaryl is nontoxic to most plants when applied at label rates (Amer, 1965). Carbaryl has been found to injure Boston ivy, Virginia creeper, and maidenhair fern (Union Carbide, 1982), as well as pears, watermelons, and some types of apples (Thomson, 1979). Minor stunting of conifer seedlings has also been observed (Sutherland et al., 1977), and retarded germination of grasses may result from excess dosages of carbaryl (Thomson, 1979).

Biological Uptake

Carbaryl is not subject to significant bioaccumulation in aquatic ecosystems because of its low solubility. Uptake of carbaryl in fish has been detected, with 95 percent excreted within 8 hours (Tompkins, 1966).

Invertebrates

Some aquatic insects in the orders Plecoptera (stoneflies) and Ephemeroptera (mayflies) are highly sensitive to low levels of carbaryl. Trichoptera (caddisflies) and Diptera (true flies) are also sensitive to carbaryl.

Aquatic Plants

Carbaryl was nontoxic to a species of fresh-water algae at 1.0 ppm.

Cultural Resources

Alternative A

No effect on cultural resources.

Alternatives B, C, and D

The only ground-disturbing activity to be encountered under these alternatives is the possible establishment of new heliport sites within forested areas.

Wilderness

The following objectives define management of insects and plant disease in Wildernesses (FSM 2324.1):

1. "To allow indigenous insect and plant diseases to play, as nearly as possible, their natural ecological role within wilderness.

2. To protect the scientific value of observing the effect of insects and diseases on ecosystems and identifying genetically resistant plant species.

3. To control insect and plant disease epidemics that threaten adjacent lands or resources."

The life cycle of the western spruce budworm suggests the lack of treatment in Wildernesses does not pose a threat to non-Wilderness (i.e., adjacent) lands nor threaten the resources within Wildernesses. Therefore, in the majority of instances, natural processes would be allowed to continue without control in Wildernesses

In situations where spruce budworm infestations in Wildernesses might affect adjacent non-Wilderness resources, treatment would be evaluated on a case-by-case basis.

Alternative A

Since the western spruce budworm is an indigenous component of the forest environment, any effects to forested areas during a naturally occurring budworm outbreak are, by policy, an acceptable part of the natural ecology.

Alternatives B, C, and D

Insecticide application would interfere with the natural processes which are a key part of the Wilderness resource.

Fire And Fuels

The No-action Alternative has little impact on fuel loading in areas where only scattered mortality occurs. The total fuel loading does not change significantly. Severe defoliation that results in areas of continuous mortality will experience high fuel loading. Forest fires result when this buildup of fuel is coupled with dry summers and lightning, or other sources of ignition.

Alternatives B, C, and D will reduce or eliminate the short-term potential for heavy fuel buildups.

All alternatives have cumulative effects on fuel levels by adding amounts of fuel to existing fuel loadings. The No-action Alternative has the most significant cumulative effect since mortality add significantly to existing fuel levels. The cumulative effects of Alternatives B, C, and D should not be significant when added to existing fuel loadings. Cumulative effects have an impact on suppression capabilities as well. As fuels are added to existing fuel beds, suppression difficulty increases.

Alternative A

The impact of continued defoliation on visual quality and the Forest users' experience will be greatest in the areas with severe defoliation.

The long-term effect of severe defoliation would result in the creation of a more diverse forest with tree species resistant to spruce budworm attack. This would result in a landscape less susceptible to change in color and texture from spruce budworm activity. This process of long-term change in tree species would take several decades.

The cumulative impact of the No-action Alternative will be the addition of acres of defoliation and visual change that occurs each year until the population is reduced by natural events.

There are conflicts with this alternative, and other plans and policies for the management of the visual resource. Conflicts result when landscape quality management objectives cannot be met due to severe defoliation impact.

Alternatives B, C, and D

Short-term protection of foliage by using *B.t.* or carbaryl reduces the change in color and texture that occurs on the landscape but does not eliminate it.

The long-term effect of protecting foliage would result in the maintenance of a forest with tree species susceptible to continued defoliation.

Notification of a pending spray project, instructing the public on safety precautions to take while visiting a project area, will cause concern and result in a short-term loss of recreation opportunity for those individuals electing not to visit the project vicinity.

The cumulative effect of implementing Alternatives B, C, or D will be the cumulative annual reduction of acres severely defoliated.

There are no conflicts expected between these alternatives and other plans and policies for management of the visual and recreation resource.

Human Health

A risk assessment was done to assess the risks to human health of using the chemical insecticide carbaryl and the biological control agent, *Bacillus thuringiensis (B.t.)* for controlling western spruce budworm in Region 6.

In essence, the risk assessment estimated doses people may get from applying the insecticides (worker doses) or from being near an application site (public doses), then compared those estimated doses with doses shown to cause no observed effects in tests on laboratory animals.

Structure of the Risk Assessment

The risk assessment employed three principal analytical elements: hazard analysis, exposure analysis, and risk analysis.

Hazard Analysis

The hazard analysis identified the toxic properties of *B.t.*, and of each chemical insecticide originally considered for the program, in a thorough review of available toxicological studies.

Exposure Analysis

The risk assessment analyzed a range of possible exposures--from realistic to extreme--using three types of scenarios: (l) typical application scenarios (routine-typical) to estimate worker and public doses that may reasonably be expected to occur during routine operations, (2) worst-case application scenarios (routine-worst case) to give very high dose estimates not likely to be exceeded except in the case of an accident, and (3) accident scenarios to estimate public and worker doses from exposure to spray mix or concentrate, directly or in spills into drinking water.

Insecticide Spraying Operations

The insecticides examined in the risk assessment are applied aerially, using fixed-wing or helicopter aircraft.

Risk Analysis

The risk of acute and chronic health effects was evaluated by comparing estimated doses to no-observed-effect-levels (NOEL's) in laboratory animal studies, using a calculated margin of safety (MOS). A benchmark risk value of 100 was used to assess the likelihood of effects. Risk increases as the estimated dose approaches the laboratory toxicity level; that is, as the MOS decreases.

Risk to more highly sensitive individuals, such as the aged or children who may be affected at extremely low exposure levels, was based on the likelihood of a sensitive individual being exposed.

Data Gaps and Uncertainties

There were a number of data gaps and areas of uncertainty identified in the risk assessment. In each of those areas, a conservative approach was used or a worst-case analysis was done that tended to increase the estimates of risk to err on the side of safety.

Risk Assessment Results

Hazard Profiles

This section summarizes the toxic properties of carbaryl, diesel oil, kerosene, and *Bacillus thuringiensis.*

Carbaryl

The review of 10 chronic toxicity, studies and the absence of significant tumor incidence at 400 ppm in rats and mice, has provided sufficient evidence for EPA to conclude "that carbaryl is not oncogenic in experimental animals" (EPA, 1988v).

Mutagenicity

The reproductive effects assessment group of EPA concluded that data from mutagenicity studies indicate that carbaryl does not act as a potent mutagen and can be classified as a weak mutagen (EPA, 1988v).

Diesel Oil

Based on an acute oral dose, diesel oil can be classified as a very slightly toxic compound.

Because diesel oil contains polycyclic aromatic hydrocarbons and other constituents that are known or suspected mutagens, it is considered to be a mutagen.

Kerosene

Kerosene can be classified as slightly toxic.

Reproductive/Developmental Toxicity

No data were available to determine the reproductive toxicity of kerosene.

Carcinogenicity

The carcinogenic potential of kerosene is similar to that of diesel oil.

Mutagenicity

Kerosene was nonmutagenic both with and without metabolic activation in the Ames bacterial and the mouse lymphoma assays (Conaway et al., 1982)

Bacillus Thuringiensis

Reproductive and Developmental Toxicity

The literature contains no data about the reproductive or teratogenic effects of *B.t.*

Carcinogenicity

The literature contains no data about the carcinogenic potential of *B.t.*

Quality of the Toxicity Data

The quality of the toxicity data base for carbaryl is adequate. Sufficient data exist from available studies to evaluate all toxicity endpoints.

Data on diesel oil and kerosene are not available for most toxicity endpoints. The quality of the data base for these two petroleum distillates must be considered inadequate.

Data do not exist for a number of toxicity endpoints for *Bacillus thuringiensis.* The quality of the data base for *B.t.* must also be considered inadequate.

Risk Of General Systemic And Reproductive Effects

Margins of safety (MOS's) were computed for workers and the public for routine operations (typical and worst-case exposures), and for accidents, for carbaryl, diesel oil, kerosene, the combined petroleum distillates, and for *B.t.*

Risk To The Public In Routine Operations

No systemic or reproductive effects are likely to result from the use of carbaryl or *B.t.* in spruce budworm supperession operations.

Margins of safety for systemic effects projected under this routine worst-case scenario are greater than 100 for carbaryl and kerosene. MOS's for diesel oil and the combined petroleum distillates are greater than 100 except for dermal and inhalation exposure to drift. These results indicate there is some slight risk of effects from diesel oil/petroleum distillate drift exposure.

Margins of Safety for Special Case Analyses

Margins of safety for persons drinking contaminated water from runoff in The Dalles Watershed were calculated. None of the MOS's are lower than 100 for any of the feeder streams. MOS's are greater than 1,000 for the reservoir itself, so there is little risk from runoff when large areas of a watershed are sprayed, even when rain occurs immediately after spraying.

Margins of safety for persons eating crops irrigated with contaminated water were calculated. MOS's are

all greater than 100, indicating very low risk from this potential route of exposure.

Risk to the Public in Accidents

The extent of effects would depend upon an individual's duration of exposure and any precautionary measures that were taken. For example, if people gathered a bushel of berries from a spray area, did not wash them but froze them, and then ate them every day for a month, they might experience ill effects such as nausea and dizziness. However, if people bathed after being in the forest or washed food items before eating them, the doses would drop (and thus substantially increase the margins of safety).

Risk To Workers From Routine Operations

Risk to Workers From Routine-Typical Exposures

Unprotected workers who routinely apply carbaryl may experience some toxic effects from the kerosene-diesel oil mixture.

Protective clothing can reduce worker exposures by 27 to 99 percent. Research has shown that such protective clothing can substantially reduce worker exposure. During insecticide applications to orchards, mixers reduced their exposure by 35 percent and sprayers reduced their exposure by 49 percent by wearing coveralls (Davies et al., 1982).

Workers who spill 500 milliliters (about half a quart) of insecticide concentrate or spray mix on their skin may experience acute toxic effects, if they do not wash the chemical off. For carbaryl in particular, this represents a clear risk of severe toxic effects if the chemical is not washed off.

Workers are not likely to be affected by carbaryl or kerosene if they are directly sprayed, but they may be affected by diesel oil and the combined petroleum distillates in the mixture.

Cancer Risks to the Public

Results for carbaryl, diesel oil, kerosene, and petroleum distillates indicate that no member of the public is at a greater than 8.5 in 100 million risk of cancer from routine exposures.

Cancer Risk to Workers

Workers are not at cancer risk greater than 1 in 1 million for any task or chemical. Cancer risks for worker accidents also do not exceed 1 in 1 million for any chemical.

Risk Of Effects From *B.t.* Contaminants (Bioburden)

Humans exposed to *B.t.* in spruce budworm suppression operations may be at some low level of risk from eye or skin irritation or infection, but are not at risk of any systemic effects from *B.t.*

Risk Of Heritable Mutations

No human studies are available that associate the insecticides considered with heritable mutations. Furthermore, no risk assessments that quantify the probability of mutations from the insecticides are available in the literature or from EPA.

Carbaryl was nonmutagenic in the majority of assays conducted and were nononcogenic in all of the carcinogenicity tests performed; therefore, it can be assumed that its mutagenic risk is slight to negligible. Kerosene and diesel oil both are considered to be possibly mutagenic.

Other Possible Effects Of The Insecticides

Factors Affecting the Sensitivity of Individuals

Factors that may affect individual susceptibility to toxic substances include diet, age, heredity, preexisting diseases, and life style (Calabrese, 1978).

Genetic factors also are known in some cases to be important determinants of susceptibillity to toxic environmental agents (Calabrese, 1984).

Persons with other types of preexisting medical conditions also may be at increased risk of toxic effects.

A series of dermal sensitization studies showed no evidence that *B.t.* could induce allergic hypersensitivity (Fisher and Rosner, 1959 as cited in Sassaman, 1987).

Cumulative Effects

No individual member of the public is likely to receive repeated exposures to any of the insecticides

because of the remoteness of most treatment units, the widely spaced timing of repeated treatments, and the use of a variety of insecticides for different purposes.

Summary Of Human Health Effects Of The Alternatives

Alternative A

This alternative should have no effect on human health because no chemical insecticides or biological controls are to be used.

Alternative B

This alternative presents the lowest risk of the alternatives apart from the No-action Alternative.

Alternative C

Carbaryl poses a human health risk only in the case of accidents. The petroleum distillates, kerosene and diesel oil, associated with carbaryl application do present a risk under routine worst case conditions and in accidents. The petroleum distillates present a degree of uncertainty in

the risk evaluation because of lack of data on their toxicity.

Alternative D

Human health risks of this alternative would be intermediate between Alternatives B and C. Risks would be reduced to the extent that *B.t.* is used instead of carbaryl.

Mitigating Measures

For any project that is implemented, a public information plan will be developed to ensure that timely notification is given about when and where spray operations will take place.

Economic Efficiency And Local Impacts

Alternatives will also result in both short- and long-term local economic impacts. These are typically measured by changes in income, earnings, employment, output, and other economic and financial conditions.

Alternative A

Under the No-action Alternative, a long-term reduction in the future supply of fiber is projected.

Alternatives B, C, and D

To the extent funding is available, investment in direct suppression with *B.t.* or carbaryl would be made in areas exhibiting the greatest net financial and intangible benefits.

Social Factors

The effects of both alternatives on consumers, civil rights, minority groups, and women are estimated to be minor. Generally, these effects are related to the supply of wood fiber and the resulting cost of wood products. Primary and secondary employment associated with the manufacture of wood products is also a consideration.

Incomplete Or Unavailable Information

Uncertain Data and Estimates

Data and information collected for the various analyses in the EIS, as well as the resulting estimates of effect and conclusions, vary in precision and accuracy. Some are based on censuses and many mutually-confirming studies. Others are based on samples and a few studies; some are estimates by professional specialists drawing on extensive experience with individual resource disciplines. The standard for determining the depth of analysis is that analysis be sufficient to provide "a clear basis for choice among options"--in this case, a choice among the four alternatives considered in this EIS.

Reasonably Foreseeable Significant Adverse Effects

An open public process was used in preparing this EIS to identify significant issues. Issues identified are issues because of the potential for reasonably foreseeable significant adverse impacts on the human environment. The potential impacts are in the areas of human health, social and economic effects, and environmental effects.

Economic Impacts

Western spruce budworm management will affect the Forest Service's ability to provide goods and services. Predicted decline in forest growth as a result of budworm defoliation can be reasonably estimated.

Environmental Impacts

By using appropriate assumptions and professional judgment, effects of actions can be reasonably estimated with confidence. While no estimate of effects for a given alternative is absolutely correct, the relative effects--compared to other alternatives--is correct. There is sufficient information with regard to environmental effects to provide a clear basis for choice among options.

Incomplete and Unavailable Information

Information is incomplete or unavailable in the following areas:

- Field studies on exposure to workers.
- Information on public exposure.
- Field data on residue levels in plants and animals.
- Mutagenicity study data for carbaryl (DNA damage)
- Toxicity information on the cumulative effects from exposure to forestry-use insecticides, other pesticides, and/or other chemicals.
- Toxicity, infectivity, and exposure information for B.t. to supplement the data from the history of its use.

Statement of Relevance

The relative human health effects of insecticies can be compared among alternatives. Comparisons were made for accidents from spills in a variety of environmental settings. The uncertainty for which there is incomplete and unavailable information is for the actual human health risks from insecticides.

Unavoidable Adverse Effects

Implementation of any alternative would result in some adverse environmental effects that cannot be avoided. Standards and guidelines and mitigating measures developed in the EIS are intended to keep the extent and duration of these effects within acceptable levels, but adverse effects cannot be completely eliminated.

Because the EIS examines alternative methods for managing western spruce budworm outbreaks the focus is on how the different methods could affect the environment. From this perspective, there are three areas of potentially significant adverse effects:

- human health risks;
- environmental effects on fish, wildlife, domestic stock and nontarget insects.
- economic effects.

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